Spin and Parity in WH → ℓνbb at DØ

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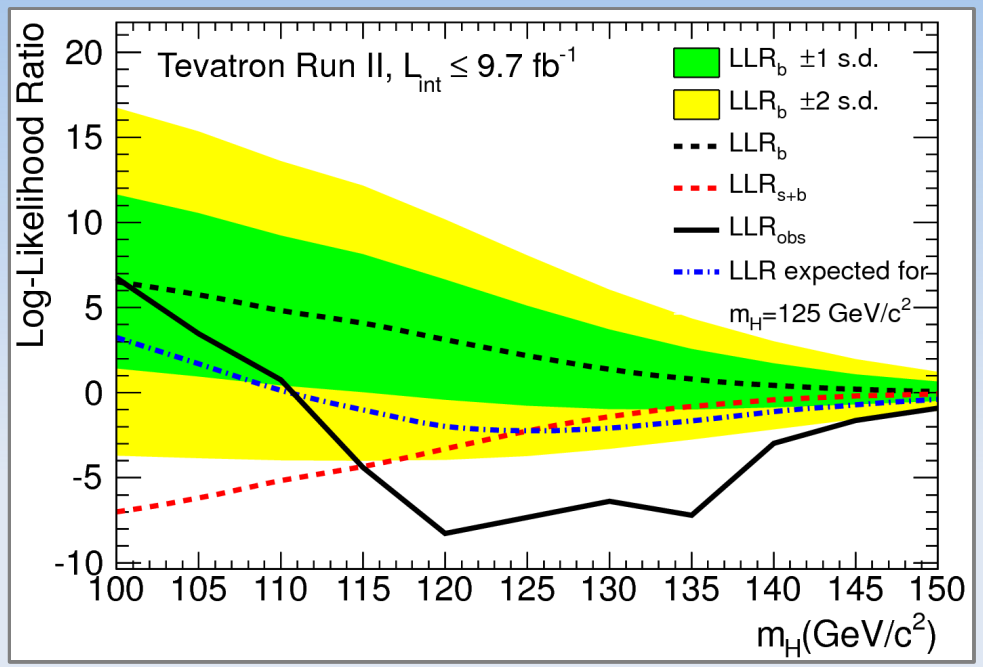
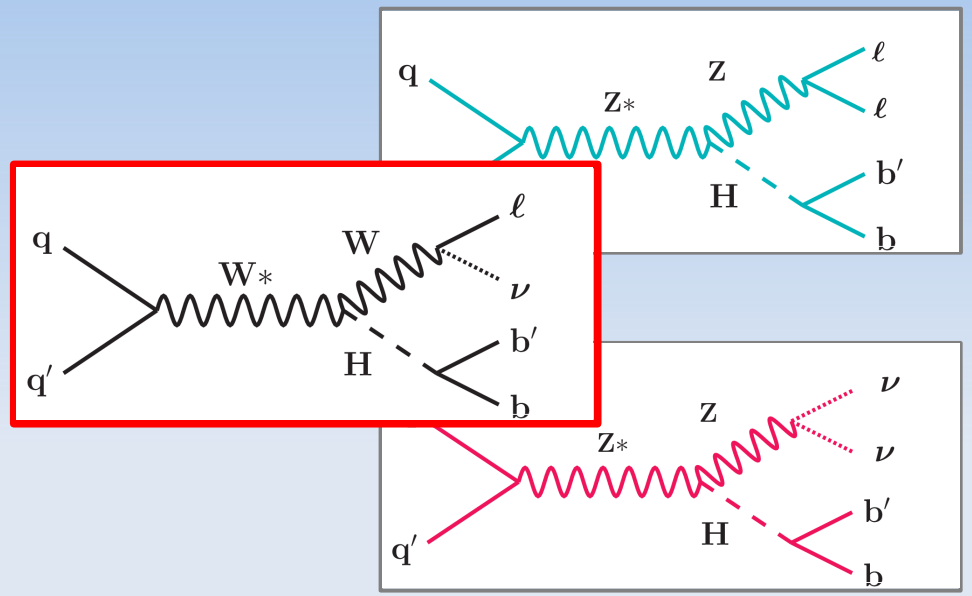
Emily Johnson
Michigan State University

Recent SMS Results





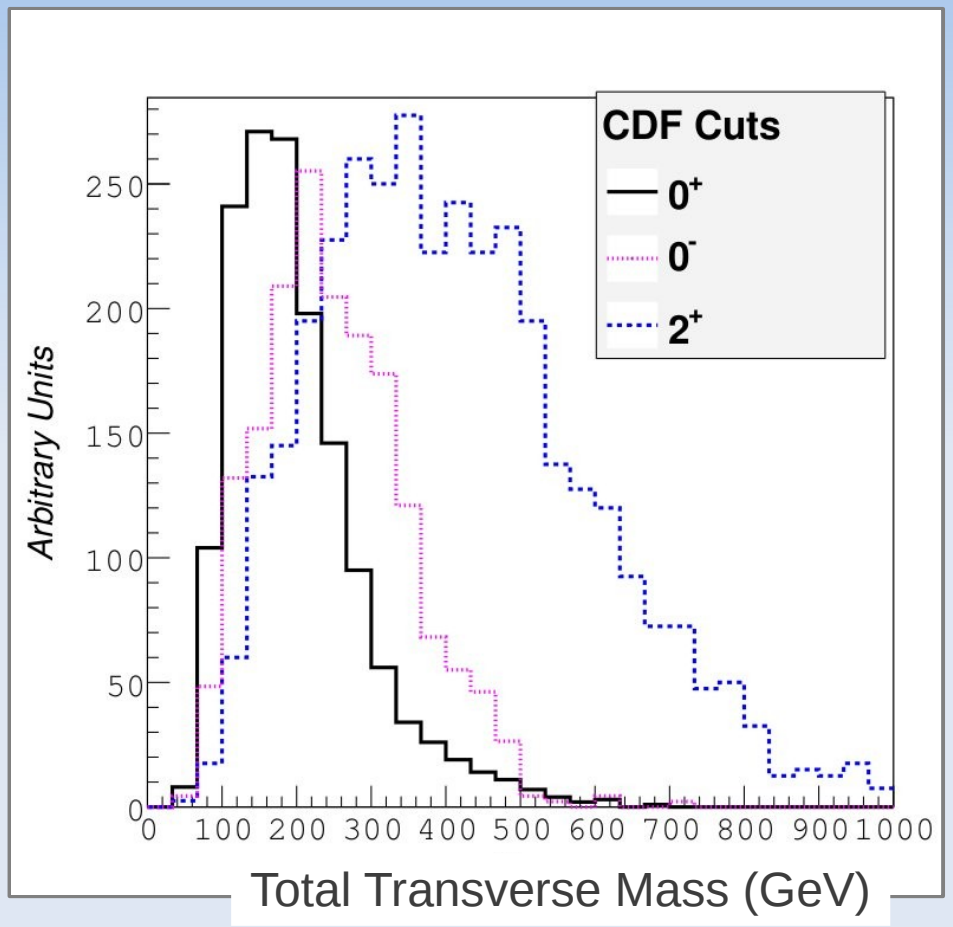
[1] Phys. Rev. Lett. 109, 071804 (2012) [12 pages]
arXiv:1207.6436 [hep-ex]

- Last summer the Tevatron showed a broad excess in the $H \rightarrow b\bar{b}$ channel
- At the same time, CMS and ATLAS announced the discovery of a boson compatible with the Standard Model Scalar (SMS) with a mass of ~125 GeV

What's Next?

- With the discovery of the SMS particle comes a round of checks
  - What mass does it have?
  - What are the coupling strengths?
  - What is its spin-parity assignment (J^P)?
- Consider 3 different possibilities:
  - Spin-0 scalar – $J^P = 0^+$
    - Standard Model predicted value
  - Spin-0 pseudo-scalar – $J^P = 0^-$
  - Spin-2 tensor – $J^P = 2^+$

Detecting Spin and Parity



Experiment	Category	Hypothesis A	Hypothesis B	Significance in σ
CDF	0l	0^+	$2^+(0^-)$	3.7 (1.3)
	1l	0^+	$2^+(0^-)$	2.5 (1.0)
	2l	0^+	$2^+(0^-)$	1.4 (0.78)
	Combined	0^+	$2^+(0^-)$	4.8 (1.6)
D0	0l	0^+	$2^+(0^-)$	3.5 (1.2)
	2l	0^+	$2^+(0^-)$	1.8 (1.2)
	Combined	0^+	$2^+(0^-)$	4.0 (1.6)
ATLAS	2l	0^+	$2^+(0^-)$	2.4 (1.1)
CMS	2l	0^+	$2^+(0^-)$	2.3 (0.70)

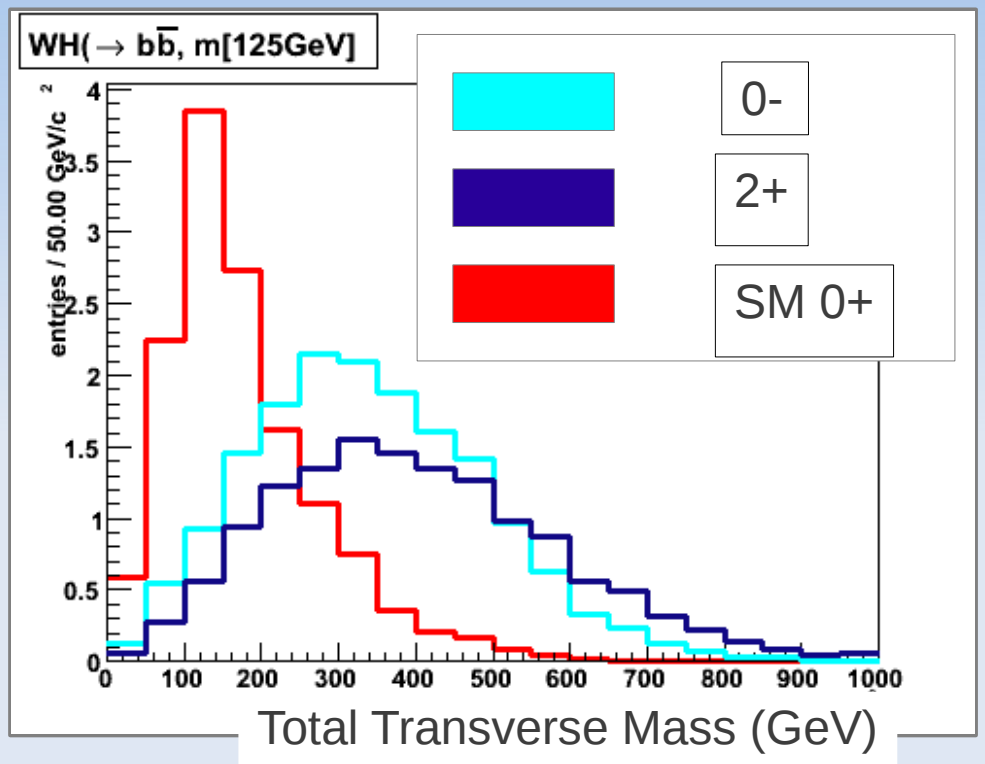
$$m_T^2 = (E_T^W + E_T^H)^2 - (\vec{p}_T^{\,W} + \vec{p}_T^{\,H})^2$$

$$\vec{p}_T^{\,W} = \vec{\not{E}}_T + \vec{p}_T^{\,\ell}$$

Caveat: Backgrounds not considered

[2] “A Fast Track towards the `Higgs' Spin and Parity” J. Ellis et al. arXiv:1208.6002 [hep-ph]

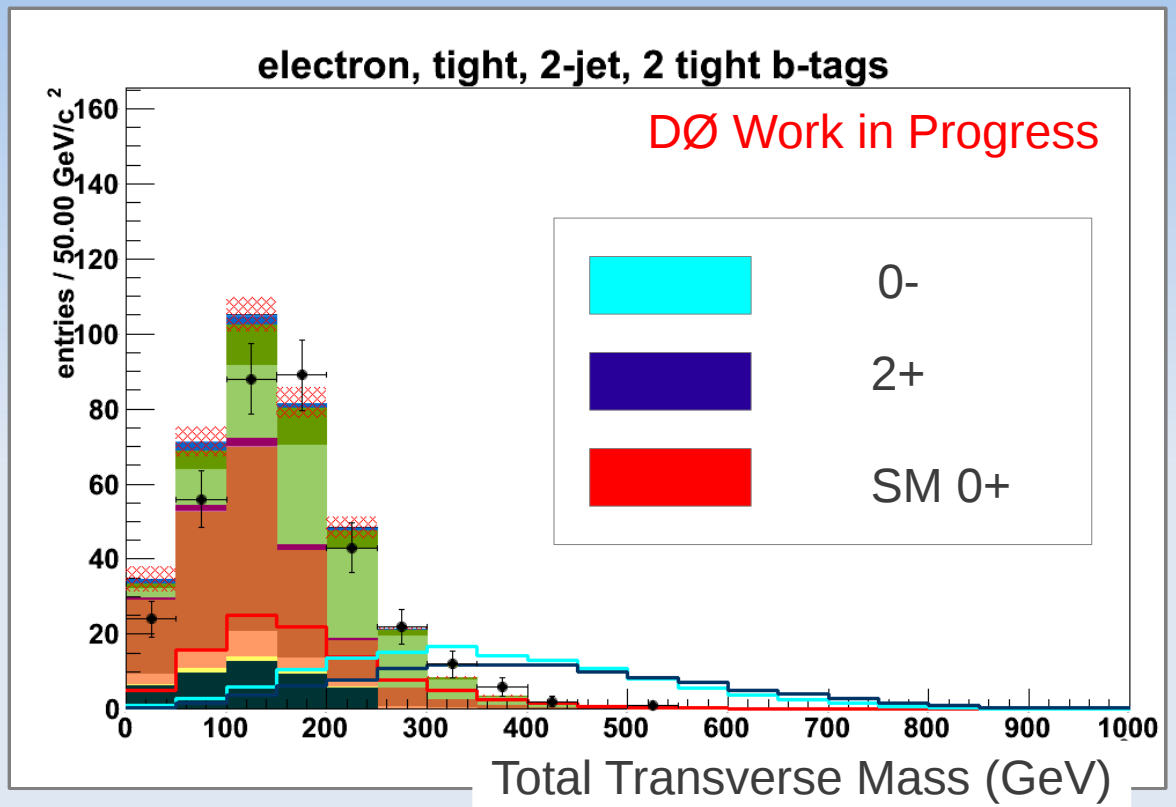
Signal Samples



Plot of signals is shown after selection and reconstruction

- Created samples using MADGRAPH5
  - Randall-Sundrum(RS) model
  - Pseudo-scalar model developed by Ellis et al. [1]
- Standard Model signal is produced with PYTHIA
- Assume SMS production rate equal to Standard Model values

Data and Monte Carlo

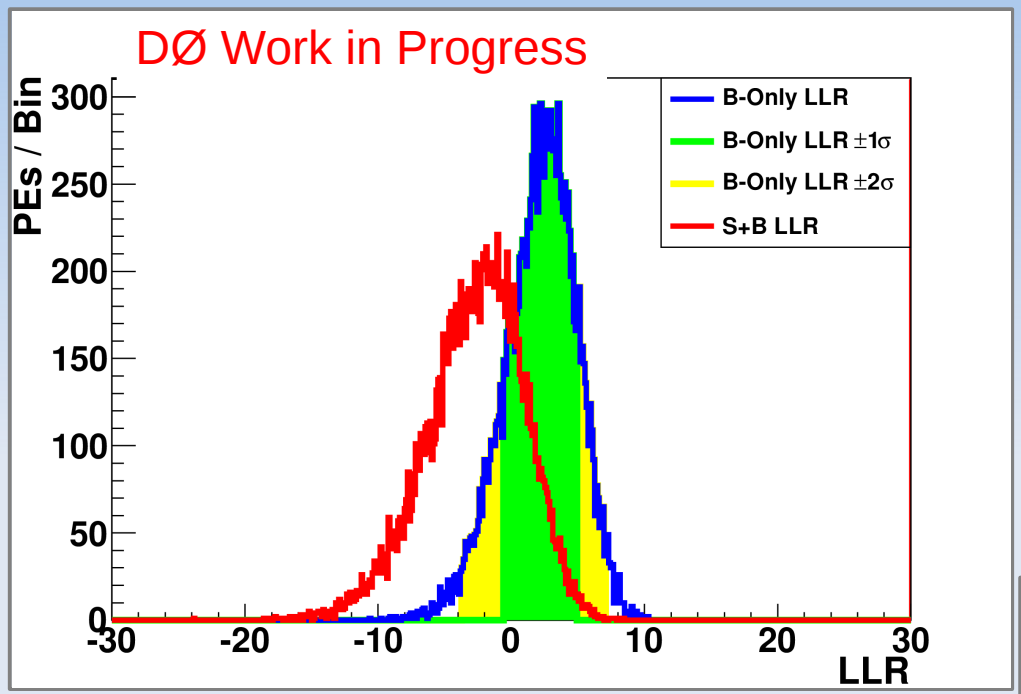


- We use the same selection as the published WH analysis

  [3] Phys. Rev. Lett. 109, 121804 (2012) arXiv:1208.0653 [hep-ex]

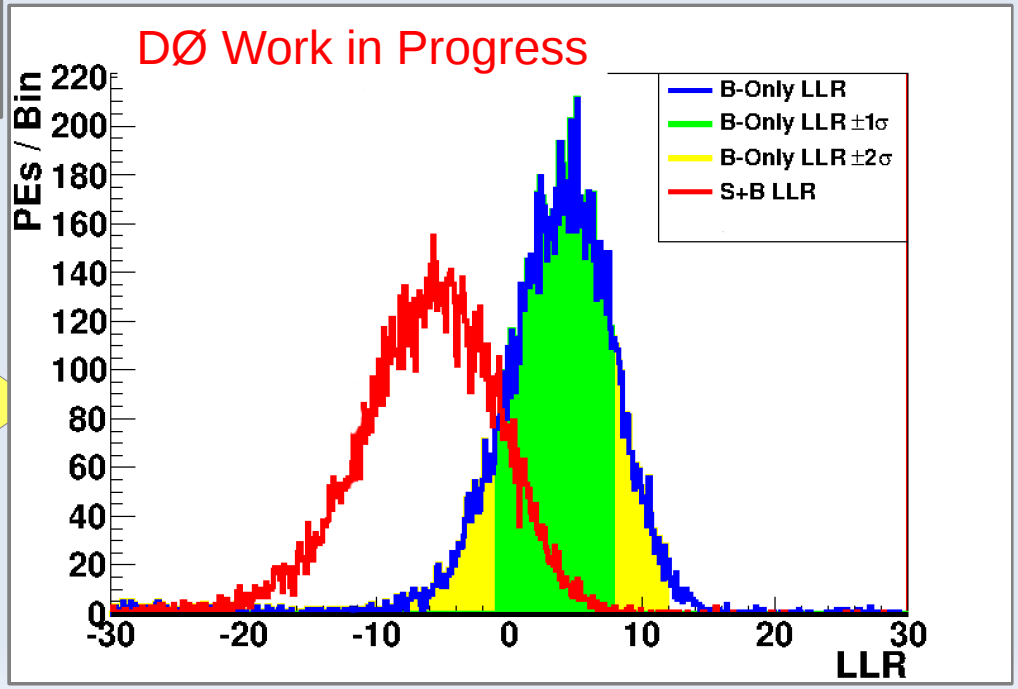
- This variable provides excellent discrimination

$J^P = 2^+$ Preliminary Discrimination



WH → ℓνbb channel only, comparing JP = 2+ to backgrounds, already see good separation...

All H → $b\bar{b}$ channels including
ZH → νν$b\bar{b}$, ZH → ℓℓ$b\bar{b}$
And WH → ℓν$b\bar{b}$



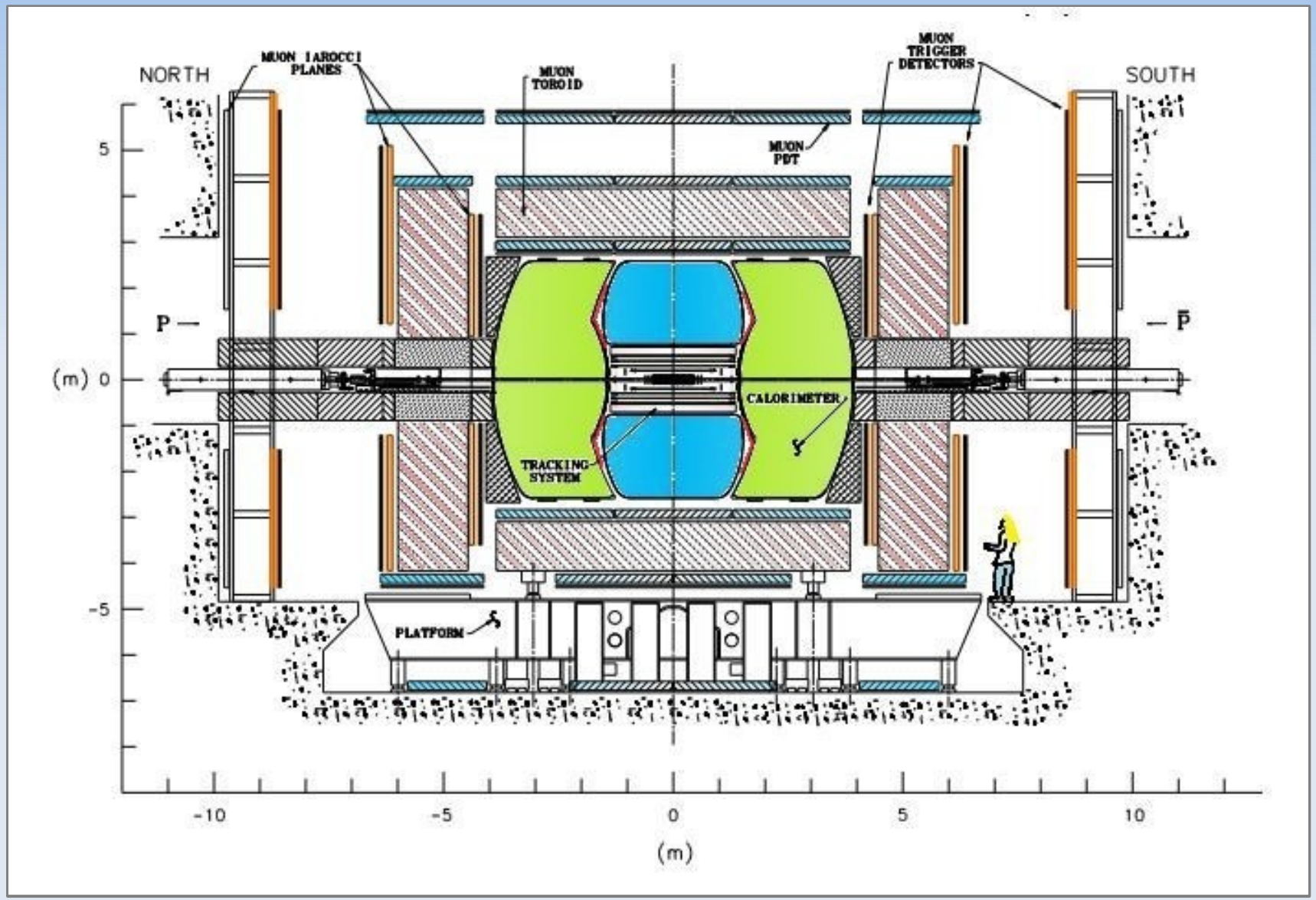
Summary

- We see good separation between the $J^P = 2^+$ signal and the background
  - We expect to see similar results when comparing the SM signal + background to the BSM signal + background
    - i.e. $J^P = 0^-$ & $J^P = 2^+$
- Further improvements
  - Dijet mass cut
  - Dedicated multivariate analysis
- We plan to publish our results in combination with CDF, so stay tuned!

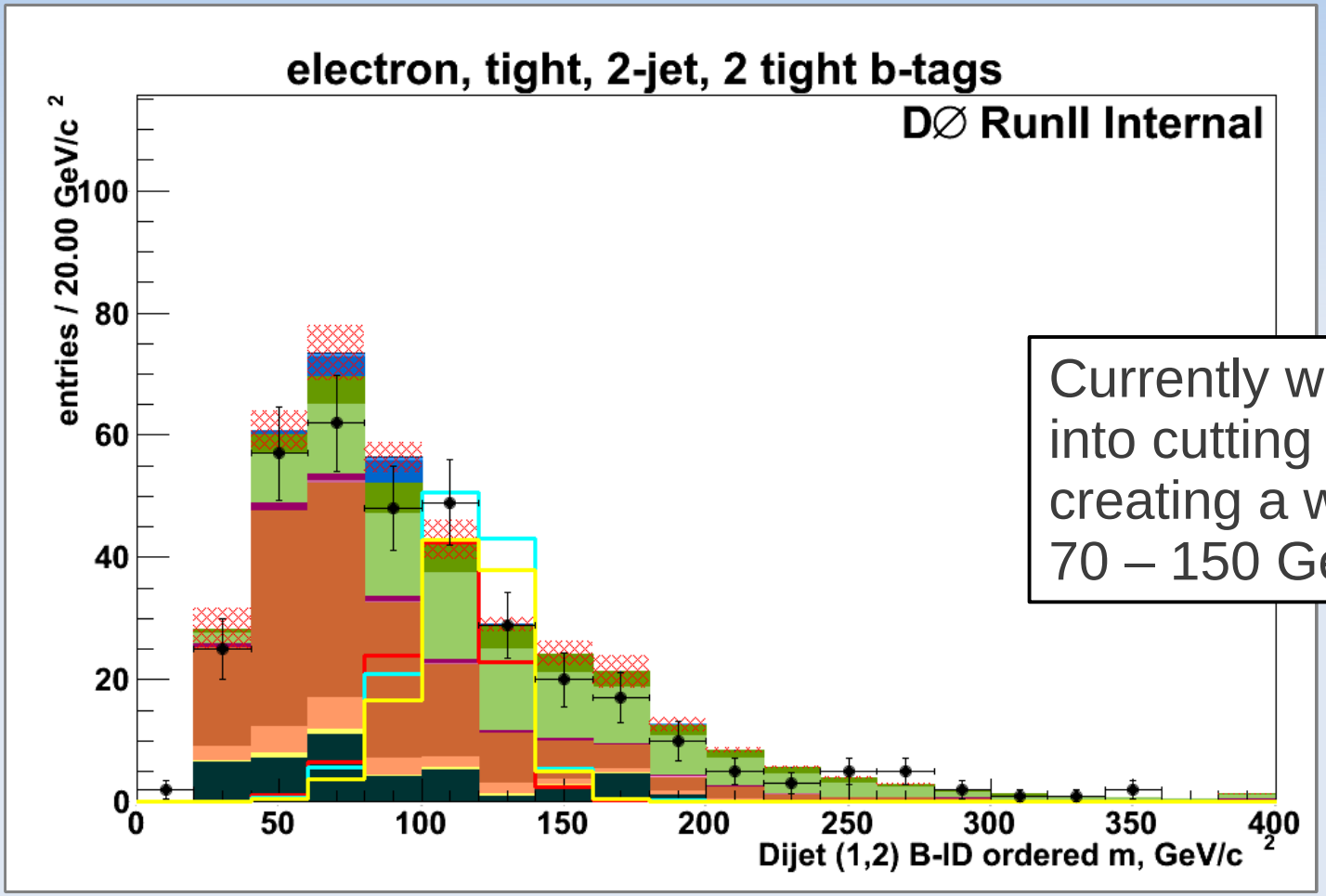
Thank you!

BACKUP

The DØ Detector



Dijet Mass Cut



Currently we are looking into cutting on the dijet mass, creating a window from 70 – 150 GeV

PYTHIA VS MADGRAPH